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Office européen des brevets



(11) Publication number : **0 382 908 B1**

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification :
19.04.95 Bulletin 95/16

(51) Int. Cl.⁶ : **G01N 21/35, G01J 3/36**

(21) Application number : **89121997.4**

(22) Date of filing : **29.11.89**

(54) **Ir-spectrometric analysing procedure and means.**

(30) Priority : **16.02.89 FI 890758**

(43) Date of publication of application :
22.08.90 Bulletin 90/34

(45) Publication of the grant of the patent :
19.04.95 Bulletin 95/16

(84) Designated Contracting States :
AT BE CH DE ES FR GB GR IT LI LU NL SE

(56) References cited :
FR-A- 2 590 979
US-A- 4 030 828
US-A- 4 279 511
US-A- 4 320 971

(56) References cited :
PATENT ABSTRACTS OF JAPAN, vol. 8, no. 165 (P-291)[1602], 31st July 1984; & JP-A-59 61 753
PATENT ABSTRACTS OF JAPAN, vol. 9, no. 210 (P-383)[1933], 28th August 1985; & JP-A-60 73 343

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EP 0 382 908 B1

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Description

The present invention concerns a spectrometric analysing process, wherein a light beam is produced and the light beam is conducted through a sample cuvette containing the sample; the transmitted light beam is diffracted to a spectrum; the measuring absorbance and reference absorbance are detected simultaneously at predetermined points in the spectrum and a value is determined from the measuring and reference absorbances.

The invention further concerns a spectrometer, comprising a light source; a sample cuvette and a path of the beam from the light source; a diffraction member for diffracting the light beam transmitted from the sample into a spectrum; detector means for detecting the intensity of the light beam at a predetermined point of the spectrum and for simultaneously detecting the intensity of the radiation transmitted at another point of the spectrum and a calculation means to determine a value corresponding to the measured absorbance on the basis of the detected measuring and reference intensities.

IR spectrometers are commonly employed in a great variety of chemical analyses.

In IR spectrometers is formed an IR absorption spectrum characterizing the substance that is being analysed and the contents of components therein. The spectrum is produced from the radiation intensity as a function of wavelength. When the spectrum is analysed, a comparison is made of its peak regions, the absorption maxima, and the corresponding absorbance value of a reference sample.

For example Patent Abstracts of Japan, Vol. 8, No. 165 describes a method to widen the selectivity of two wavelengths, wherein optical fibers as means for selecting a wavelength were used.

US-A-4 320 971 refers to a special processing of spectrometrically obtained signals: It is electrically scanning to obtain a converted signal corresponding to a desired wavelength in the UV and the near-infrared region. Object of US-A-4 320 971 is to improve the measuring speed and reliability of a spectrophotometer. The problems are solved by a spectrophotometer providing an image sensor capable of electrically scanning structured for outputting photo-electrically converted signals which were treated by a processing circuit. Electrical switching means are provided to process a measured signal and to be able to select a special wavelength and to produce a signal related thereto.

FR-A-2 590 979 relates to the measuring of a spectrum in UV and the near IR (300 to 800 nm), i.e. measures the part of the spectrum that ends in the visible. This document is related especially to the use of means to have a polychromator for the analysis of a number of weak peaks, e.g. of different trace elements nearby a strong peak. Especially FR-A-2 590

979 relates to a means to deviate a beam in form of a quartz sheet which is used to deviate a measured signal in a predetermined frequency. This way, a polychromator is made - nevertheless there is no information how to measure quantitatively exactly at the same time two signals like in the invention, but signals are obtained shortly one after the other by means of this quartz sheet that is used for a quasi-simultaneous measurement. FR-A-2 590 979 therefore cannot be used for turbulent solutions as it measures not at the same time two signals.

US-A-4 279 511 relates to UV detectors that are used in chromatographic analysers. Such a means measures UV absorption within the range between 180 nm and 600 nm with a typical UV detector as it is commonly used for detecting substances that are eluted from liquid chromatography. The spectrometer detected therein is used to detect a UV absorption maximum and to measure thereby the fact whether the substance is still in the solution or whether this substance has been eluted already from the separating column. So the spectrometer does not measure a quantitative value, but it is just arranged to be able to detect qualitatively a certain substance. Therefore the detectors do not measure an absorbance at a fixed point and calculate the content of the substance but this system measures whether a UV absorbing substance is there at all or not. So the evaluation circuit thereof is not meant in any means to measure concentration but just to measure the exact wavelength of the absorption and the duration of the peak. In US-A-4 279 511 the user does not know exactly when and where and which substance shall be measured, therefore a displacement of the detectors is possible and further the sample of the apparatus is continuously changing as a throughflow cell is used.

The spectrometer and the method used in US-A-4 279 511 are throughflow spectrometers that detect the presence of UV absorbing substances during elution. Contrary to this the inventive spectrometer detects the amount of a specified material that is measured very fast, so that any turbulence or moving of the molecule cannot disturb the exact measuring and the forming of an information by a calculating circuit. IR spectrometers are very temperature sensitive therefore measurement must be done very quickly and reliably so that no influence of temperature or movement disturbs the measuring.

For the expert in the field of spectrometry it is quite clear that there is a big difference between the technics of the measuring of different wavelength radiations so that there is no possibility to transfer the knowledge of spectrometers for UV radiation completely on IR spectrometers.

Furthermore it is known in the art to determine contents of substances causing absorption in the IR range by a procedure wherein first is measured the absorbance at the wavelength corresponding to a

chemical bond typical of the substance in question, at which said bond has an absorption maximum, and thereafter is measured a reference absorbance at another wavelength differing from the absorption maximum. The content of the substance is calculated by comparing the two absorbances.

For instance to the purpose of measuring the fat, protein and lactose present in milk and milk products with IR light, it is common practice to use a rotating filter disk on which are mounted filters corresponding to the measuring absorbance and reference absorbance of each substance to be measured. In the measurements corresponding filters are used, and the filters are changed as required.

When measurements are performed, the optical point of measurement is located in a measuring cuvette, whereby between measurements movements of molecules of the constituents from one location to another can take place even while the solution or suspension to be measured is merely standing in the cuvette. As a result, conditions in the measuring cuvette at two consecutive points of time may differ even greatly.

This means in practice that a reference absorbance measurement and a sample absorbance measurement made at different times cannot usually be made of the same molecules nor under the same conditions of measurement. Therefore a measuring system based on different measuring times cannot operate as a reliable arrangement which would be able to yield correct content values.

Content readings of different substances measured on one and the same sample may also be unreliable because they too are measured at different times, and possibly under different conditions in the measuring cuvette. The situation becomes particularly problematic when the sample that is being measured is a dispersed system, for instance an emulsion or a suspension, of which the dispersed constituents turbulate in the measuring cuvette. This situation obtains, for instance, in the case of milk and of products processed from milk, both containing for instance fat globules and casein, which is either solid or semi-solid, depending on its degree of polymerization.

As a rule, the parameters of the IR spectrometer, the analysing conditions and/or the quality of the samples change continuously so that one has to perform frequent calibration runs, up to several per day. In particular, the filters of the IR spectrometer are sensitive to temperature variations, and thus temperature variations cause inaccuracy in the end results. Furthermore, the way in which the grating or equivalent, the light source, detector, sample cuvette or equivalent component or member is mounted may cause displacement of said component e.g. as a consequence of temperature variation, vibration or the like.

Moreover, the components of IR spectrometers

of prior art, e.g. IR filters, are rather expensive, and this fact substantially increases the price of IR spectrometers.

The object of the present invention is to eliminate the drawbacks pointed out in the foregoing and to provide a novel IR-spectrometric analysing process and spectrometer in which the drawbacks presented above do not occur to such extent as heretofore.

It is particularly an aim of the invention to provide a novel IR-spectrometric analysing process and spectrometer which are particularly well suited for determining the contents of the components of various emulsions and suspensions, in particular of mixtures encountered in the foodstuff industry.

It is particularly an aim of the invention to provide a novel IR-spectrometric analysing process and spectrometer in which the characteristic quantities, particularly the position of light source, grating or equivalent, detector, sample cuvette or other components or members will not change as easily as they do in earlier IR spectrometers.

The object is solved by a spectrometric analysing process characterized in, that the light is IR radiation and the measuring absorbance is detected at a peak of the IR spectrum and the reference absorbance is detected at a minimum of the IR spectrum immediately adjacent to said peak with the use of a dual beam detector and that the difference between the measuring and the reference absorbances is formed in said dual beam detector.

Furthermore the invention concerns a spectrometer characterized in, that the detector means comprises at least one dual beam detector which is enabled to detect a light intensity in the IR spectrum at a peak of the IR spectrum and a reference absorbance at a minimum of the IR spectrum immediately adjacent to said peak and to form the difference between the measuring absorbance and the reference absorbance.

The invention is based on the fundamental idea that the detector has been arranged to detect the measuring absorbance and the reference absorbance simultaneously from a light beam that has passed through the sample and has been diffracted to a spectrum. This may for instance be implemented in that the light radiating from an IR source is directed on the sample placed in a sample cuvette, the light obtained from the cuvette is diffracted, or divided, to produce a spectrum, by optical means with the aid of a diffraction member, e.g. a curved grating or a prism. From the spectrum thus obtained the measuring absorbance and reference absorbance corresponding to given desired wavelengths, or their difference, are detected with the aid of a detector or detectors, i.e., in the measuring absorbance and reference absorbance detector, or detectors, are formed signals corresponding to the measuring absorbance and to the reference absorbance or to their ratio or difference or

another quantity dependent on them.

The wavelengths corresponding to the detected measuring absorbance and reference absorbance are naturally determined in accordance with the point of measurement in the IR spectrum. The points of measurement may for instance be selected to correspond to the absorbance peaks of desired components, or to correspond to desired absorbance values. The measuring absorbance and reference absorbance are then advantageously determined in two mutually adjacent wavelength intervals of the IR spectrum. The measuring absorbance is advantageously detected at a peak of the IR spectrum and the reference absorbance, at the minimum immediately beside the peak.

Calculations are based on using an internal reference, that is, the reference value is determined from the sample, e.g. the IR spectrum in accordance with an absorbance value which is constant at different concentrations of the respective component. The content of the measured component can then be calculated directly on the basis of the ratios of the detected measuring absorbance and reference absorbance, or similarly on the basis of their difference.

Determination of a given desired component is made by calculation in a way known in itself in the art; the implementation of the calculations, and calculating means, for finding the content of a given component are known in themselves and shall not be described in greater detail in this connection.

With the process and spectrometer of the invention excellent reliability of the measurements is achieved. The measuring absorbance and reference absorbance are detected at the same moment and under identical conditions, that is from the same molecules. The result is highly reliable and represents the sample such as it was at the time of measurement, at the point of measurement, and without any potential changes taking place as a function of time.

The process and spectrometer of the invention are applicable in IR-spectrometric measurements exceedingly well in the case of dispersed systems, e.g. emulsions and suspensions, in which the measuring errors occurring due to the effect of turbulence are eliminated, thanks to the invention. One may thus particularly contemplate emulsions selected from the group: fat-, protein emulsions, and possibly in addition a substance selected from the group: carbohydrates, urea and other ketone substances, and antibiotics.

Another important advantage gainable with the invention is the swiftness of the measurements, that is, that the measuring absorbance and the reference absorbance, or their difference or equivalent signals, can be detected simultaneously in a very brief moment, which is on the order of milliseconds in practice. Being such, the arrangement is remarkably faster than e.g. the use of a filter disk known through the

state of art, in the case of which each measurement requires two consecutive measuring operations. When the absorbance values of several substances are measured from one sample and two absorbance readings are taken for each substance, the measuring process takes long and is unreliable using a filter disk.

Furthermore with the invention the major advantage is gained that it is not necessary to use in the device any filters likely to undergo ageing, and presenting performance values which change with time.

Furthermore, when a grating is used for diffraction member, no moving parts subject to wear are required in the optics, whereby the characteristic properties of the means will be unchanged and results of measurement are mutually comparable.

A diffraction member is here understood to be any kind of member diffracting an IR beam to a spectrum, such as a grating, prism or other member in which IR radiation produces a spectrum.

The diffraction member is advantageously curved and constitutes part of a circle, cylinder or spherical surface.

The detector or detectors are advantageously placed substantially on the periphery of the same circle, or on the surface of the same sphere, as the diffraction member.

The spectrometer comprises one, advantageously several, detectors which detect the intensity of the IR spectrum incident on the location of the detector, at the respective point. The system that is used may consist of one or several detectors. If two separate detectors are used, one may be disposed to detect the measuring absorbance and the other the reference absorbance. The detector may further be for instance dual beam detector which measures differential intensities between IR beams entering the detector, such as e.g. a pyroelectric dual beam detector, manufactured e.g. by Hamamatsu, Japan, or by EITec, U.S.A., etc.

The light source, diffraction member and detector or detectors are advantageously fixedly mounted in relation to each other.

The invention is described in the following in detail with the aid of an embodiment example, referring to the attached drawing, wherein:-

Fig. 1 presents schematically an IR spectrometer according to the invention;

Fig. 2 presents a schematic diagram showing the implementation of the procedure of the invention; and

Fig. 3 presents the measuring absorbance and reference absorbance bands in a measurement according to the invention.

In Fig. 1 is seen an IR spectrometer according to the invention. The spectrometer substantially comprises the following elements known in themselves in the art: a light source 1, a chopper 2, a sample cuvette 5, a diffraction member 6 and a detector 7. The light

rays are directed through the sample cuvette 5 into the diffraction member 6.

The chopper 2 is of any previously known kind whatsoever, for instance a mechanical chopper with a rotating punched plate through which the light beam is conducted. The chopper is previously known through IR spectrometers and is not more closely described in this connection. A chopper is usually necessary because as a rule IR detectors measure IR radiation intensities on the basis of the respective changes.

The diffraction member in the well-known way disperses the light beam into a spectrum, which is detected with the aid of the detector 7. The diffraction member 6, such as a grating, prism or other diffraction member dispersing light to produce a spectrum, is advantageously curved. The side of the diffraction member facing the light beam substantially forms part of a circular surface. The diffraction member may constitute, for instance, part of a spherical surface, it may be a planar part of a cylindrical surface, or it may constitute part of a circular arc.

The diffraction member is advantageously disposed on a circular arc or on the surface of a sphere. The detector 7 is then advantageously disposed on the same circular arc or on the surface of the same sphere.

The means advantageously comprises at least one dual detector; in the embodiment presented there have been depicted three separate dual detectors 8¹-8³, each one of them measuring the intensity of the corresponding location in the IR spectrum arriving at the respective site, at two different points; e.g. pyroelectric IR detectors. The detectors have been disposed to measure intensities of the light beam conducted from the light source through the sample, at different points of the spectrum, that is, to produce the corresponding signals or a quantity dependent thereon, such as their quotient or difference.

The means depicted in Fig. 1 further comprises three pairs of detectors 8⁴,8⁵; 8⁶,8⁷ and 8⁸,8⁹, which have been disposed to measure two different IR wavelengths, a measuring absorbance and a reference absorbance each pair.

The detectors have been placed at desired points on the circumference. The dimensions of the circle, cylinder or sphere defined by light source, chopper, cuvette and diffraction member can be arranged for instance so that 1 mm on said circumference corresponds to a wavelength differential of e.g. 100 nm, or to another given wavelength differential. Furthermore the detectors, for instance two mutually adjacent detectors, may be arranged so that the spacing of the points of measurement of the dual detector, respectively the spacing of the two separate detectors, is 1 mm and they have been placed so that one point of measurement, respectively one detector, coincides in location with an absorbance maximum of the IR

spectrum and the other point of measurement, respectively detector, is located at the preceding, adjacent minimum to measure the background, that is, the substantially constant reference level.

When an IR spectrum is being measured with the means of the invention, the IR spectrum is formed in a manner known in itself in the art, by effect of the diffraction member, on the inner surface of the respective sphere. Those dual beams, that is absorbances, which are desired are detected, that is measured as such, their ratio is measured, the differential voltage produced by them is measured or the ratio dependent on them is measured, whence the respective content can be determined directly with the aid of a signal processing unit 11 and a calculating means 8, e.g. a computer, and with the aid of the known reference absorbance of the sample.

In Fig. 1, the light source 1, chopper 2, sample cuvette 5, diffraction member 6 and detectors 7 have been advantageously mounted fixedly in relation to each other. Then, the characteristic properties of the IR spectrometer will not change significantly during analysis, and there is no need to move or turn the diffraction member or the detectors relative to each other.

In Fig. 1 the dual detector 8¹ has been arranged to measure the difference between the measuring absorbance $_1$ and reference absorbance $_2$ of the beam that has been conducted through the sample 5 to the diffraction member 6 and dispersed to a spectrum to constitute a measuring beam and a reference beam.

Further in Fig. 1 the detector pair 8⁸,8⁹ has been arranged to measure the measuring absorbance $_1$ and reference absorbance $_2$ of the beam dispersed by the diffraction member 6 to a spectrum.

In Fig. 2 is seen the implementation of the procedure of the invention, mainly employing an arrangement as shown in Fig. 1. The light beam formed by the light source 1 is carried to the chopper 2 and further through the sample cuvette 5 to the diffraction member 6. The diffraction member disperses the light to a spectrum, and the desired part of the spectrum is measured with the aid of two detectors, e.g. 8⁸,8⁹ (Fig. 1). The detectors 8⁸,8⁹ detect the wavelength region of a given maximum of the IR absorption spectrum, that is the measuring interval M, $_1$, and simultaneously the reference point R of the minimum adjacent to said maximum, that is the wavelength interval $_2$. The IR spectrum IR, measuring interval M and reference interval R have been illustrated in Fig. 3. The detectors produce signals corresponding to the measured absorbances, the measuring absorbance M and the reference absorbance R, which have been conducted to an amplifier/signal processing unit 11, which processes the signals. Finally, the results of measurement obtained from the signal processing unit have been carried to a calculating means 9, such as a microprocessor, for producing the measurement-

of-content result C of the desired component.

When dual beam detectors are used, such as pyroelectric dual beam detectors, these are exceedingly low in price. Furthermore, no specific, expensive filter is required in the detector, whereas conventional equivalent apparatus usually contains a filter for the particular desired wavelength. Furthermore, thanks to the pyroelectric dual beam detectors, which are internally connected to oppose each other and are therefore compensated in view of temperature and vibration, the output voltage will be smooth, corresponding to the differential intensity measured, that is e.g. to the concentration of the measured solution.

The embodiment example is merely meant to illustrate the invention, and any embodiments of the invention may vary within the scope of the claims following below.

Claims

1. Spectrometric analysing process, wherein a light beam is produced and the light beam is conducted through a sample cuvette containing the sample; the transmitted light beam is diffracted to a spectrum; the measuring absorbance and reference absorbance are detected simultaneously at predetermined points in the spectrum and a value is determined from the measuring and reference absorbances,
characterized in,
that the light is IR radiation and the measuring absorbance is detected at a peak of the IR spectrum and the reference absorbance is detected at a minimum of the IR spectrum immediately adjacent to said peak with the use of a dual beam detector and that the difference between the measuring and the reference absorbances is formed in said dual beam detector.
2. Process according to claim 1,
characterized in,
that the transmitted IR radiation is conducted from the sample to diffraction means placed substantially on the periphery of a circle and the measuring absorbance and reference absorbance are detected at a peripheral point of this circle.
3. Process according to claim 1 or 2,
characterized in,
that the sample measured is a dispersion, emulsion or suspension subject to turbulence.
4. Process according to claim 3,
characterized in,
that the system comprises substances selected from the group of fat and proteins, carbohydrates,

ketones, urea, antibiotics and mixtures thereof.

5. Spectrometer comprising a light source (1); a sample cuvette (5) and a path of the beam from the light source; a diffraction member (6) for diffracting the light beam transmitted from the sample into a spectrum; detector means for detecting the intensity of the light beam at a predetermined point of the spectrum and for simultaneously detecting the intensity of the radiation transmitted at another point of the spectrum and a calculation means (9) to determine a value corresponding to the measured absorbance on the basis of the detected measuring and reference intensities
characterized in,
that the detector means (7) comprises at least one dual beam detector (8) which is enabled to detect a light intensity in the IR spectrum at a peak of the IR spectrum and a reference absorbance at a minimum of the IR spectrum immediately adjacent to said peak and to form the difference between the measuring absorbance and the reference absorbance.
6. Spectrometer according to claim 5,
characterized in,
that the diffraction member (6) is substantially on a circular arc (10) and the dual beam detector(s) (8) is/are placed on a different point of said arc of the same circle.
7. Spectrometer according to claim 5 or 6,
characterized in,
that the light source (1), the diffraction member (6) and the dual beam detector(s) (8) are placed in fixed relation to each other.

Patentansprüche

1. Spektrometrisches Analyseverfahren, bei dem ein Lichtstrahl hergestellt und der Lichtstrahl durch eine Probeküvette, die die Probe enthält, geleitet wird; der transmittierte Lichtstrahl in ein Spektrum zerlegt wird; die gemessene Absorption und die Referenzabsorption an vorherbestimmten Punkten im Spektrum gleichzeitig bestimmt werden und ein Wert aus den gemessenen und Referenz-Absorptionen ermittelt wird, dadurch gekennzeichnet, daß das Licht IR-Strahlung ist, die gemessene Absorption an einem Peak des IR-Spektrums und die Referenzabsorption an einem unmittelbar neben diesem Peak befindlichen Minimum des IR-Spektrums unter Verwendung eines Zweistrahlendetektors gemessen wird, und die Differenz zwischen gemessener und Referenzabsorption bestimmt wird.

ferenzabsorption im Zweistrahl-detektor gebildet wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die transmittierte IR-Strahlung von der Probe zu Diffraktionsmitteln geleitet wird, die im wesentlichen auf dem Umfang eines Kreises angeordnet sind, wobei die gemessene Absorption und die Referenzabsorption an einem Punkt auf dem Umfang dieses Kreises bestimmt werden. 5
3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die gemessene Probe eine Dispersion, Emulsion oder eine turbulente Suspension ist. 10
4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß die Probe Substanzen ausgewählt aus der Gruppe bestehend aus Fetten, Proteinen, Kohlehydraten, Ketonen, Harnstoffen, Antibiotika und Mischungen derselben, aufweist. 15
5. Spektrometer mit einer Lichtquelle (1); einer Probeküvette (5) und einem Strahlengang von der Lichtquelle; einem Diffraktionsmittel (6) zur Diffraktion des von der Probe transmittierten Lichtstrahles in ein Spektrum; Detektionsmittel zur gleichzeitigen Detektion der Intensität des Lichtstrahles an einem vorherbestimmten Punkt des Spektrums und der an einen anderen Punkt des Spektrums geleiteten Strahlung; und einer Recheneinheit (9) zur Bestimmung eines Wertes, der der gemessenen Absorption auf Basis der gemessenen und Referenzintensitäten entspricht, dadurch gekennzeichnet, daß die Detektoreinrichtung (7) mindestens einen Zweistrahl-detektor (8) aufweist, der die Lichtintensität im IR-Spektrum an einem Peak des IR-Spektrums und die Referenzabsorption an einem Minimum des IR-Spektrums unmittelbar benachbart diesem Peak messen und die Differenz zwischen der gemessenen Absorption der Referenz-Absorption bilden kann. 20
6. Spektrometer nach Anspruch 5, dadurch gekennzeichnet, daß das Diffraktionsteil (6) sich im wesentlichen auf einem kreisförmigen Bogen (10) befindet und der/die Zweistrahl-detektor(en) (8) an einem anderen Punkt dieses Bogens des gleichen Kreises angeordnet ist/sind. 25
7. Spektrometer nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß die Lichtquelle (1), das Diffraktionsteil (6) und der Zweistrahl-detektor (8) in fester Beziehung zueinander angeordnet sind. 30

Revendications

1. Un procédé d'analyse spectrométrique dans lequel un faisceau lumineux est produit et le faisceau lumineux est conduit à travers une cuvette pour échantillon contenant ledit échantillon; le faisceau lumineux transmis est diffracté en un spectre, l'absorbance de mesure et l'absorbance de référence sont détectées simultanément à des points prédéterminés dans le spectre et une valeur est déterminée à partir des absorbances de mesure et de référence, caractérisé en ce que la lumière est un rayonnement IR, en ce que l'absorbance de mesure est détectée à un pic du spectre IR et l'absorbance de référence est détectée à un minimum du spectre IR immédiatement adjacent audit pic, en employant un détecteur double de faisceau et, en ce que la différence entre les absorbances de mesure et de référence, est établie dans ledit détecteur double de faisceau. 35
2. Procédé selon la revendication 1° caractérisé en ce que le rayonnement IR transmis est conduit de l'échantillon au moyen de diffraction placé essentiellement sur la périphérie d'un cercle et l'absorbance de mesure et l'absorbance de référence sont détectés en un point sur la périphérie de ce cercle. 40
3. Procédé selon la revendication 1 ou la revendication 2° caractérisé en ce que l'échantillon mesuré est une dispersion, une émulsion ou une suspension, soumise à turbulence. 45
4. Procédé selon la revendication 3° caractérisé en ce que le système comprend des substances choisies dans le groupe formé des matières grasses et des protéines, des hydrates de carbone, des cétones, de l'urée, des antibiotiques et des mélanges de ceux-ci. 50
5. Spectromètre comprenant une source lumineuse (1); une cuvette pour échantillon (5) et un chemin du faisceau depuis la source lumineuse, un élément de diffraction (6) pour effectuer la diffraction du faisceau lumineux transmis à partir de l'échantillon dans un spectre; des moyens de détecteurs pour détecter l'intensité du faisceau lumineux à un point prédéterminé du spectre et pour détecter simultanément l'intensité du rayonnement transmis en un autre point du spectre et un moyen de calcul (9) pour déterminer une valeur correspondant à l'absorbance mesurée de la base des intensités de mesure et de référence détectées, caractérisé en ce que le moyen de détecteur (7) comprend au moins un détecteur double de faisceau (8) qui est en mesure de détecter 55

une intensité lumineuse dans le spectre à un pic du spectre IR et une absorbance de référence au minimum du spectre IR immédiatement adjacent audit pic, et de former la différence entre l'absorbance mesurée et l'absorbance de référence.

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6. Spectromètre selon la revendication 5° caractérisé en ce que l'élément de diffraction (6) est essentiellement sur un arc circulaire (10) et le détecteur double du faisceau (8) est/sont placés à un point différent dudit arc du même cercle.

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7. Spectromètre selon la revendication 5° ou la revendication 6° caractérisé en ce que la source lumineuse (1), l'élément de diffraction (6) et le détecteur double de faisceau (8) sont placés dans une relation fixée l'un par rapport aux autres.

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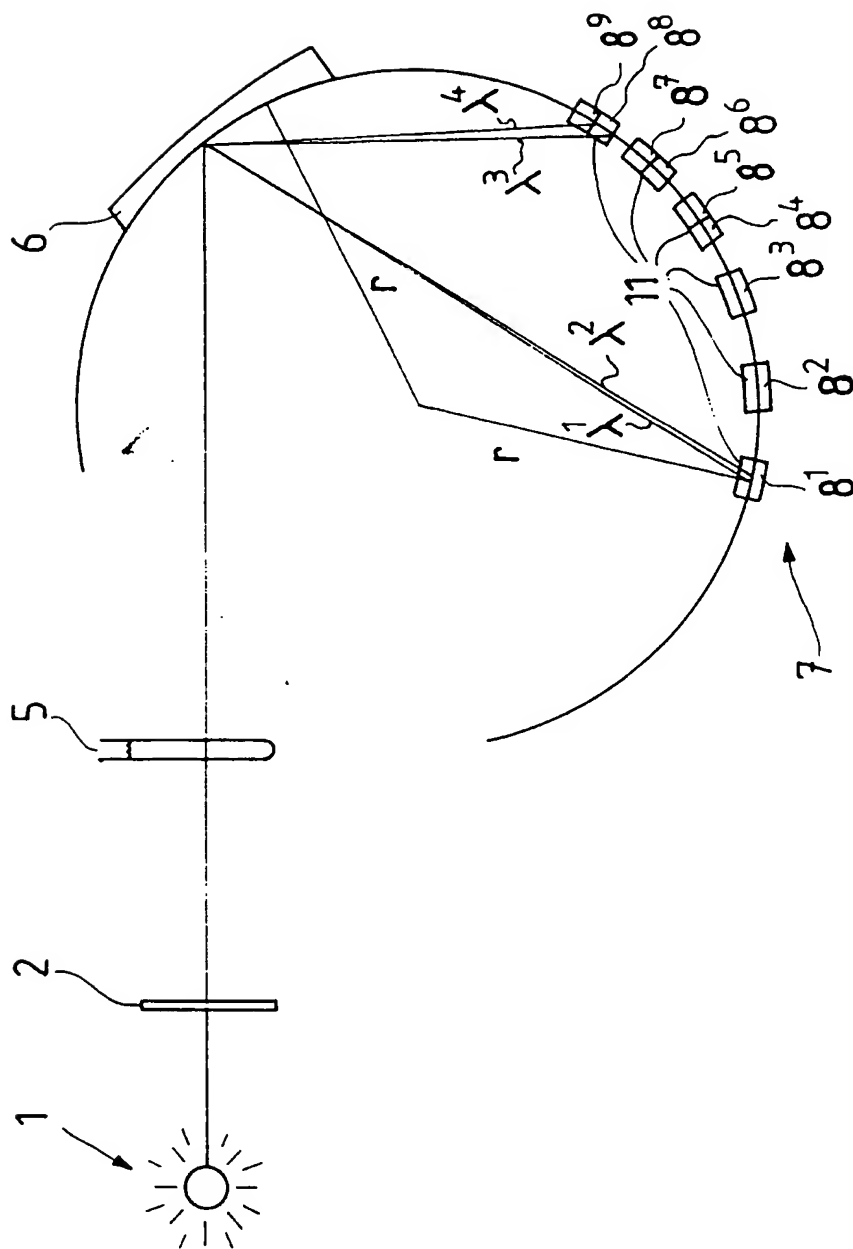


Fig.1

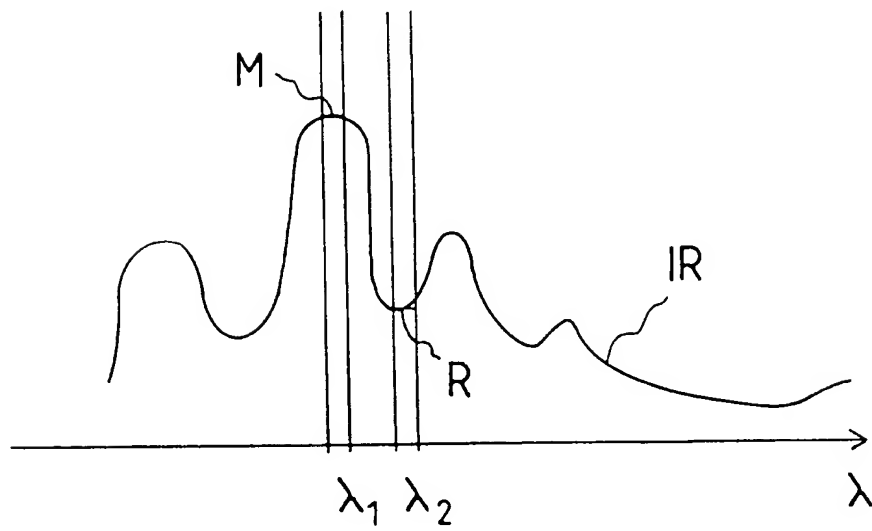
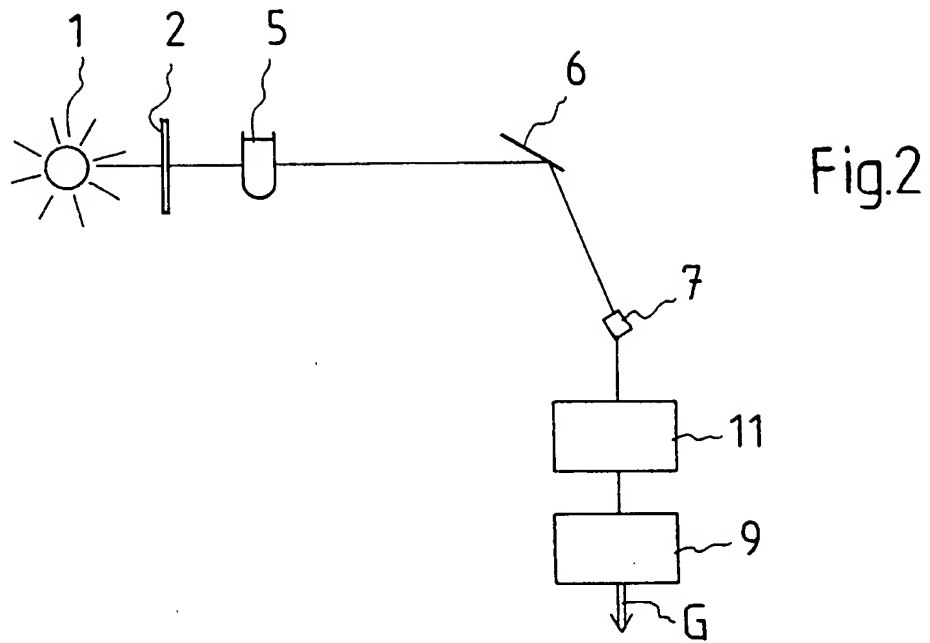


Fig.3